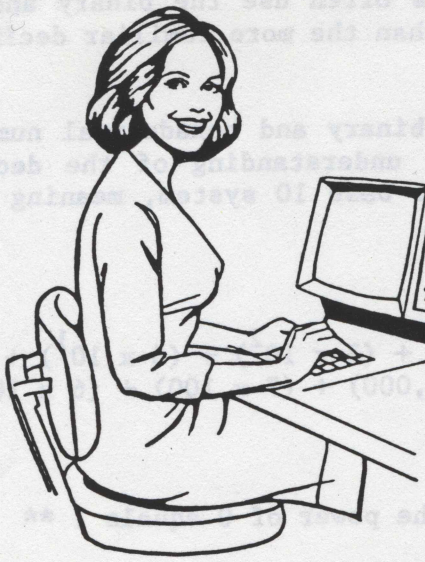
f(x)



Journal

Hello, this is the 3rd F(x) Journal. Again, we are sorry for the irregular intervals of the F(x) Journal. (This is the Dec. '82 edition.) We expect to be on schedule starting with the January issue of 1983.

In this newsletter you will find:

- Machine Language Tutorial - part 3
- Explanation of Sound Generation

Machine Language Tutorial - part 3

The Binary and Hexadecimal Number Systems

Machine language programmers often use the binary and hexadecimal number systems, often much more than the more familiar decimal (base 10) system.

In order to understand the binary and hexadecimal number systems, one must first grasp a through understanding of the decimal system. Note that the decimal system is a base 10 system, meaning a multiplier of some power of 10.

Example:

10769 (base 10)
$= (1 \times 10^4) + (0 \times 10^3) + (7 \times 10^2) + (6 \times 10^1) + (9 \times 10^0)$
$= (1 \times 10{,}000) + (0 \times 1{,}000) + (7 \times 100) + (6 \times 10) + (9 \times 1)$
$= 10{,}000 + 700 + 60 + 9$
$= 10769$

** Note that any number to the power of 0 equals 1 **

The binary system works much the same way, with two exceptions:

1. The base is 2, not 10
2. The only valid digits are 0 and 1

In the binary (base 2) system, each digit is a multiplier of some power of 2.

Example:

10110101 (base 2)
$= (1 \times 2^7) + (0 \times 2^6) + (1 \times 2^5) + (1 \times 2^4) + (0 \times 2^3) +$
$(1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$
$= (1 \times 128) + (0 \times 64) + (1 \times 32) + (1 \times 16) + (0 \times 8) +$
$(1 \times 4) + (0 \times 2) + (1 \times 1)$
$= 128 + 0 + 32 + 16 + 0 + 4 + 0 + 1$
$= 181$ (base 10)

** Note that the power of the base of the right most digit is 0. **
** The remaining power increase by 1 as you moves to the left. **

The hexadecimal system also works much the same as the decimal system with 2 exceptions:

1. The base is 16, not 10
2. All of the digits, 0-9, are valid with the addition of the following values :

A = 10 , B = 11 , C = 12 , D = 13 , E = 14 , F = 15

In the hexadecimal (base 16) system, each digit is a multiplier of some power of 16.

Example:

A20C (base 16)
$= (A \times 16^3) + (2 \times 16^2) + (0 \times 16^1) + (C \times 16^0)$
$= (10 \times 16^3) + (2 \times 16^2) + (0 \times 16^1) + (12 \times 16^0)$
$= (10 \times 4096) + (2 \times 256) + (0 \times 16) + (12 \times 1)$
$= 40960 + 512 + 0 + 12$
$= 41484$ (base 10)

Often it may be helpful to perform addition in the binary system. Here are the rule of binary addition:

1. 0 + 0 = 0
2. 1 + 0 = 1
3. 0 + 1 = 1
4. 1 + 1 = 0, plus a carry to the next left column

Example:

```
   10011101          (157 base 10)
   01010110          ( 86 base 10)
   --------          -------------
   11110011          (243 base 10)
```

Subtraction in the binary system is performed much the same way as addition. To perform binary subtraction, simply take the 2's complement of the subtracted number and then add the two numbers.

Example:

```
   10011011
  -10111011
  ---------
```

To fin the 2's complement of a number, change the 0's to 1's, and add 1. The 2's complement of 10111011 = 01000101.

```
   10011011
  +01000101
  ---------
   11100000
```

In short, the binary and hexadecimal number systems are important for the machine language programmer to understand and to implement.

SOUND GENERATION

Have you ever wondered how sound is really generated ? Sound in the Imagination Machine is generated with software routine, meaning that producing sound ties up the microprocessor for the duration of the sound. This also could mean slower program execution unless sophisticated " programming tricks" are used. These "tricks", however, are beyond the scope of this article.

Hardware-wise, the sound electrical singal is produced by the control line 2 of the B control register in one of the 6821 PIA's. (PIA is Peripheral Interface Adapter) This particular control line is programmed as an output by the IM's ROM routines. The output is coupled to the RF section of the computer.

Software-wise, to cause the output line to oscillate (switch on and off), one need only change a bit in the control register. This control register is located at address 8195 (2003 hexadecimal). The bit which must be oscillated is bit 3. Enter and run the following program:

```
10 FOR I = 1 TO 500
20 POKE 8195,60
30 POKE 8195,52
40 NEXT I
```

Note that this routine is slow and produces a very low tone. To further decrease the tone, insert a time delay between lines 30 and 40. This routine can be used to produce tones lower than those available with the MUSIC command. All in all, the best way to use this method to produce sound is with machine language. This method can be used to produce intersting, often otherwise unavailable, sounds and sound effects.

IN CLOSING

I would like to thank you all for your immense understanding with our irregular schedule. We hope to have "opening day problems" cleared up very, very soon.

NEXT MONTH

- Machine Language tutorial - part 4
- Useful POKE's and PEEK's
- Much more

P.S.

Do any of you out there know how to get orange pop out of a word processing diskette ? If so please send your suggestions to:

The Clutz
828 Butternut Dr.
Holland, MI 49423

Thank you for any suggestions !!!

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